CLAIMS:

[C001] 1. A method of forming a waveguide comprising:

depositing a photodefinable copolymer material comprising methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer over a substrate;

fixing optical elements relative to the photodefinable copolymer material;

sending light through at least one of the optical elements and the photodefinable copolymer material towards the other of the optical elements; and

volatilizing uncured monomer from the photodefinable copolymer material to form the waveguide.

[C002] 2. The method of claim 1 further comprising providing the photodefinable copolymer material by a process comprising:

mixing tetrafluoropropyl methacrylate, methyl methacrylate, cyclohexanone, a chain transfer agent, and benzoyl peroxide;

degassing, heating, and cooling the resulting mixture; and

adding and mixing anisole and the epoxy monomer.

[C003] 3. The method of claim 1 wherein volatilizing comprises forming a single-mode waveguide.

[C004] 4. The method of claim 1 wherein fixing the optical elements comprises fixing elements selected from the group consisting of waveguides, fibers, light emitting devices, light detecting devices, and combinations thereof.

[C005] 5. The method of claim 1 wherein sending the light comprises controlling the light intensity to be slightly above a threshold condition for volatilization of the photodefinable copolymer material.

[C006] 6. The method of claim 5 wherein the acts of sending the light and volatilizing the uncured monomer are performed in sequence at least twice with each subsequent performance resulting in an extension of the waveguide.

[C007] 7. The method of claim 1 wherein sending the light through the at least one of the optical elements and the photodefinable copolymer material towards the other of the optical elements comprises sending the light through each of the optical elements and the photodefinable copolymer material towards the other of the optical elements.

[C008] 8. The method of claim 7 wherein sending the light comprises controlling the light intensity to be slightly above a threshold condition for volatilization of the photodefinable copolymer material.

[C009] 9. The method of claim 8 wherein the acts of sending the light and volatilizing the uncured monomer are performed in sequence at least twice with each subsequent performance resulting in an extension of the waveguide.

[C010] 10. The method of claim 4 wherein fixing occurs after depositing.

[C011] 11. The method of claim 4 wherein fixing occurs prior to depositing.

[C012] 12. The method of claim 11 wherein depositing comprises depositing the photodefinable copolymer material between the optical elements.

[C013] 13. The method of claim 1 wherein sending light through at least one of the optical elements comprises using a writing light source to supply light through a first path of a splitter and expose the waveguide, using a signal light source to supply light through a second path of the splitter, and monitoring the resulting waveguide to evaluate the path of the signal light.

[C014] 14. The method of claim 1 wherein volatilizing the uncured monomer from the photodefinable copolymer material to form the waveguide comprises forming a ridge waveguide.

[C015] 15. The method of claim 14 further comprising depositing and curing a first core layer on the substrate, and wherein depositing the photodefinable copolymer material over the substrate comprises depositing a second core layer over the first core layer.

[C016] 16. The method of claim 1 wherein volatilizing the uncured monomer from the photodefinable copolymer material to form the waveguide comprises forming a loaded waveguide.

[C017] 17. The method of claim 16 further comprising depositing and curing a core layer on the substrate, wherein depositing the photodefinable copolymer material over the substrate comprises depositing a cladding layer over the core layer.

[C018] 18. The method of claim 1 wherein the optical elements comprise photonic modules and are fixed on a substrate, wherein depositing the photodefinable copolymer material comprises depositing the copolymer material between optically active segments of the photonic modules.

[C019] 19. A method of forming and using a waveguide comprising:

depositing a photodefinable copolymer material over a substrate;

fixing optical elements relative to the photodefinable copolymer material, at least one of the optical elements comprising a splitter;

sending light through the at least one of the optical elements and the photodefinable copolymer material towards another of the optical elements, wherein sending comprises supplying light through the at least one of the optical elements through a first path of the splitter;

volatilizing uncured monomer from the photodefinable copolymer material to form the waveguide; and

using the waveguide by transmitting an optical signal through a second path of the splitter.

[C020] 20. The method of claim 19 wherein sending light through at least one of the optical elements comprises using a writing light source to supply light through a first path of a splitter and expose the waveguide, using a signal light source to supply light through a second path of the splitter, and monitoring the resulting waveguide to evaluate the path of the signal light.

[C021] 21. The method of claim 20 wherein the writing light source comprises an Argon laser and the signal light source comprises a helium neon laser.

[C022] 22. The method claim 19 wherein the photodefinable copolymer material comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

[C023] 23. The method of claim 22 further comprising providing the photodefinable copolymer material by a process comprising:

mixing tetrafluoropropyl methacrylate, methyl methacrylate, cyclohexanone, a chain transfer agent, and benzoyl peroxide;

degassing, heating, and cooling the resulting mixture; and

adding and mixing anisole and the epoxy monomer.

[C024] 24. A method of forming a waveguide comprising:

fixing optical elements relative to each other, each having an optical surface;

providing a blob over at least portions of the optical surfaces of the optical elements, the blob comprising a photodefinable copolymer material resulting in sufficient surface tension with respect to the optical surfaces to result in the blob having a curved surface;

sending light through each of the optical elements and the blob towards the curved surface and another of the optical elements with an incident angle from one of the optical elements with respect to the curved surface being larger than a total

internal reflection condition determined by an index of refraction difference between the blob and air surrounding the blob; and

volatilizing uncured monomer from the blob to form the waveguide.

[C025] 25. The method of claim 24 wherein the blob comprises a polymer binder and sufficient quantities of an uncured monomer to diffuse into the irradiated area of the blob during volatilizing.

[C026] 26. The method of claim 25 further comprising, when sufficient volatizing and diffusion have occurred, blanket-exposing the blob.

[C027] 27. The method of claim 24 wherein fixing comprises positioning one optical element over a horizontal surface of the substrate and inserting another optical element in a vertical opening of the substrate.

[C028] 28. The method of claim 24 further comprising, after volatilizing, depositing a reflection enhancing layer over at least a portion of the curved surface of the blob.

[C029] 29. The method of claim 28 wherein the reflection enhancing layer comprises a metal.

[C030] 30. The method of claim 24 further comprising, prior to providing the blob, treating the optical surfaces to tailor the surface roughness.

[C031] 31. The method of claim 30 wherein treating comprises polishing.

[C032] 32. The method of claim 30 wherein treating comprises applying a coating layer prior to providing the blob.

[C033] 33. The method claim 24 wherein the blob comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

[C034] 34. The method of claim 33 wherein providing the blob comprises:

mixing tetrafluoropropyl methacrylate, methyl methacrylate, cyclohexanone, a chain transfer agent, and benzoyl peroxide;

degassing, heating, and cooling the resulting mixture; and

adding and mixing anisole and the epoxy monomer.

[C035] 35. A method of forming a waveguide comprising:

fixing optical elements relative to each other, each having an optical surface;

aligning a mirror to direct light from one of the optical elements to the other of the optical elements;

providing a photodefinable copolymer material between the optical surfaces and the mirror;

sending light through at least one of the optical elements towards the other of the optical elements; and

volatilizing uncured monomer from the photodefinable copolymer material to form the waveguide.

[C036] 36. The method of claim 35 wherein sending light comprises sending light through each of the optical elements towards the other of the optical elements.

[C037] 37. The method claim 35 wherein the photodefinable copolymer material comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

[C038] 38. The method of claim 37 wherein providing the photodefinable copolymer material comprises:

mixing tetrafluoropropyl methacrylate, methyl methacrylate, cyclohexanone, a chain transfer agent, and benzoyl peroxide;

degassing, heating, and cooling the resulting mixture; and

adding and mixing anisole and the epoxy monomer.

[C039] 39. A method of forming an optical path comprising:

fixing optical elements relative to each other, each having an optical surface;

translating and rotating a mirror until the mirror is aligned to optimally direct light from one of the optical elements to the other of the optical elements; and

securing the aligned mirror in position.

[C040] 40. The method of claim 39 wherein translating and rotating the mirror until the mirror is aligned to optimally direct light from the one of the optical elements to the other of the optical elements comprises sending light from the one of the optical elements and translating and rotating to maximize light detected by the other of the optical elements.

[C041] 41. The method of claim 39 wherein fixing the optical elements comprises fixing the optical elements so that the optical surfaces are substantially orthogonal.

[C042] 42. The method of claim 39 wherein fixing comprises positioning one optical element over a horizontal surface of a substrate and positioning another optical element in a vertical opening of the substrate.

[C043] 43. The method of claim 42 further comprising providing a substrate including a dielectric layer thereon, the dielectric layer having a notch therein with at least one end situated over the vertical opening, wherein the mirror is situated on a fiber, and wherein translating comprises moving the fiber down the notch and rotating comprises rotating the fiber within the notch.

[C044] 44. The method of claim 43 wherein securing comprises providing a copolymer material between the optical surfaces and the mirror.

[C045] 45. The method of claim 44 wherein the copolymer material comprises a photodefinable copolymer material, and wherein the optical path comprises a waveguide, the method further comprising sending light through at least one of the optical elements towards the other of the optical elements; and volatilizing uncured monomer from the photodefinable copolymer material to form the waveguide.

[C046] 46. The method of claim 43 wherein securing comprises providing an optical material between the optical surfaces and the mirror, curing the material, and then removing the optical mirror.

[C047] 47. A waveguide comprising: a blob over optical surfaces of optical elements fixed relative to each other, the blob comprising a pre-cured copolymer material having sufficient surface tension with respect to the optical surfaces to form a curved surface, a core portion of the blob comprising a material having a higher index of refraction than another portion of the blob and forming a reflective path between the optical surfaces.

[C048] 48. The waveguide of claim 47 one optical element is positioned over a horizontal surface of the substrate and another optical element is positioned in a vertical opening of the substrate.

[C049] 49. The waveguide of claim 47 further comprising a reflection enhancing layer over at least a portion of the curved surface of the blob.

[C050] 50. The waveguide of claim 49 wherein the reflection enhancing layer comprises a metal.

[C051] 51. The waveguide of claim 47 further comprising a surface treating coating layer between the optical surfaces and the blob.

[C052] 52. The waveguide claim 47 wherein the blob comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

[C053] 53. A waveguide comprising:

optical elements fixed relative to each other, each having an optical surface;

a mirror aligned to direct light from one of the optical elements to the other of the optical elements;

a photodefinable copolymer material between the optical surfaces and the mirror, a core portion of the photodefinable copolymer material comprising a material having a higher index of refraction than another portion of the photodefinable copolymer material and forming a reflective path between the optical surfaces.

[C054] 54. The waveguide of claim 53 wherein the photodefinable copolymer material comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

[C055] 55. An optical path comprising:

optical elements fixed relative to each other, each having an optical surface; and

a mirror situated on a fiber and aligned to optimally direct light from one of the optical elements to the other of the optical elements.

[C056] 56. The optical path of claim 55 the optical surfaces are substantially orthogonal.

[C057] 57. The optical path of claim 55 wherein one optical element is positioned over a horizontal surface of a substrate and another optical element is positioned in a vertical opening of the substrate.

[C058] 58. The optical path of claim 57 further comprising a dielectric layer on the substrate, the dielectric layer having a notch therein with at least one end situated over the vertical opening.

[C059] 59. The optical path of claim 58 further comprising a copolymer material between the optical surfaces and the mirror.

[C060] 60. The optical path claim 59 wherein the copolymer material comprises methyl methacrylate, tetrafluoropropyl methacrylate, and an epoxy monomer.

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